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CONDUCTIVE HIGH-TENSILE COPPER ALLOY

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Abstract

PURPOSE: To develop a Cu alloy for electronic and electrical equipment parts excellent in strength, elongation, thermal and electric conductivities, solderability, plating suitability, adhesive strength of scales, and corrosion resistance, by adding specific elements to a Cu alloy containing Cr and Si in a specific ratio.

CONSTITUTION: A Cu alloy prepared by incorporating, by weight, 0.1-5% Cr, 0.02-1% Si (Si content is regulated to Cr/5.6 or below, where Cr means a stoichiometric ratio of Cr), and <0.003% O₂ and also incorporating 0.01-0.15%, each, of P, As, and Sb, 0.05-1.0%, each, of Ni, Co, and Al, 0.01-0.5%, each, of Zr, Mg, and Te, 0.01-1.0%, each, of Fe, Mn, Ta, Nb, Ag, misch metal, and Ti, and 0.01-3.0%, in total, of 1 or >=2 kinds among 0.05-0.3%, each, of Zn, Sn, and Be to Cu is used as a material for semiconductor lead frames, lead wires, various terminals, connectors, conductive springs, etc.

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(54) CONDUCTIVE HIGH-STRENGTH COPPER ALLOY

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Specification

1. Title of the Invention

CONDUCTIVE HIGH-STRENGTH COPPER ALLOY

2. Scope of Patent Claim

(1) A conductive high-strength copper alloy containing 0.1 – 5 wt% Cr and 0.02 – 1.0 wt% Si, and further containing a total of 0.01 – 3 wt% of any one or two or more of the following, within the range of 0.01 – 0.15 wt% P, 0.01 – 0.15 wt% As, 0.01 – 0.15 wt% Sb, 0.05 – 1 wt% Ni, 0.05 – 1 wt% Co, 0.01 – 0.5 wt% Zr, 0.01 – 0.5 wt% Mg, 0.01 – 1 wt% Fe, 0.05 – 3 wt% Zn, 0.05 – 3 wt% Sn, 0.05 – 1 wt% Al, 0.05 – 0.3 wt% Be, 0.01 – 1 wt% Mn, 0.01 – 1 wt% Ta, 0.01 – 1 wt% Nb, 0.01 – 0.5 wt% Te, 0.01 – 1 wt% Ag, 0.01 – 1 wt% misch metal, and 0.01 – 1 wt% Ti, with the remainder consisting of Cu.

(2) The conductive high-strength copper alloy of claim 1, wherein the amount of Si is the stoichiometric ratio of Cr or less and the amount of O₂ is 0.003 wt% or less.

3. Detailed Description of the Invention

[Industrial Field of Use]

The present invention pertains to conductive high-strength copper alloys used in the conductors, leads, conductive springs, terminals, etc., of electronic

equipment and in particular, presents copper alloys that are useful for miniature, high-density semiconductor lead frames.

[Prior Art]

Copper alloys are widely used in electronic equipment, for instance, the leads of semiconductors, terminals of various components, and conductive springs, such as connectors, switches, etc. Phosphor bronze is very popular because its strength is 50 – 65 kg/mm² and because it has excellent workability. Nevertheless, these alloys have a conductivity that is low at 10 – 20% [IACS] and therefore, they cannot be used in components that require conductivity (heat transferability). In particular, they cannot be used for miniature, highly integrated semiconductors. Therefore, Cu-Fe, Cu-Zr, Cu-Ni-Si, etc., alloys are used in part.

[Problems solved by the invention]

Although Cu-Fe alloys, for instance C-194 (Cu-2.4 wt% Fe-0.12 wt% Zn-P alloy) and C-195 (Cu-1.5 wt%-0.8 wt% Co-0.6 wt% Sn-P alloy) have a conductivity of 50 – 65% IACS and a strength of 45 – 55 kg/mm², when the strength is increased further, workability and solderability decrease. Although Cu-Cr alloys show a conductivity of as high as 80 – 90% IACS, the coarse crystals of Cr readily precipitate and when the Cr is brought to 0.7 wt% (hereafter wt% is abbreviated as %) or more and the strength is increased to 55 kg/mm² or stronger, the workability as well as the homogeneity and isotropy of the materials are lost. Moreover, although Cu-Zr alloys have a conductivity of 90% IACS or higher, their strength is low at 40 kg/mm² or lower. Cu-Ni-Si alloys are alloys in which Ni₂Si precipitates and depending on the combination of Ni and Si and

production conditions, there is a reduction in their conductivity and solderability. That is, there is inevitably a reduction over time in the strength of the soldered components due to the unreacted Ni and Si, and this becomes a fatal flaw with the standard mounted state of being soldered to a printed substrate, etc.

In light of this, there is a need for the development of alloys having excellent mechanical properties, including strength, elongation, etc., heat and electrical conductivity, and solderability, plating performance, scale adhesion, corrosion resistance, such as resistance to stress corrosion cracking, etc., that is, alloys that are ideal for semiconductor lead materials that must be of high performance.

[Means for solving problems]

The present invention involves conductive high-strength copper alloys ideal for miniature high-density semiconductor lead frames that were developed as a result of various studies based on the above-mentioned problems. It is characterized in that it involves high-strength copper alloys containing 0.1 – 5 wt% Cr and 0.02 – 1.0 wt% Si, and further containing a total of 0.01 – 3 wt% of any one or two or more of the following, within the range of 0.01 – 0.15 wt% P, 0.01 – 0.15 wt% As, 0.01 – 0.15 wt% Sb, 0.05 – 1 wt% Ni, 0.05 – 1 wt% Co, 0.01 – 0.5 wt% Zr, 0.01 – 0.5 wt% Mg, 0.01 – 1 wt% Fe, 0.05 – 3 wt% Zn, 0.05 – 3 wt% Sn, 0.05 – 1 wt% Al, 0.05 – 0.3 wt% Be, 0.01 – 1 wt% Mn, 0.01 – 1 wt% Ta, 0.01 – 1 wt% Nb, 0.01 – 1 wt% Te, 0.01 – 1 wt% Ag, 0.01 – 1 wt% misch metal (hereafter abbreviated MM), and 0.01 – 1 wt% Ti, with the remainder consisting of Cu. It is particularly preferred that, within the above-mentioned composition

range, the amount of Si be brought to the stoichiometric ratio of Cr or less and the amount of O₂ be brought to 0.003% or less.

The above-mentioned alloys can be easily produced by conventional methods to provide the desired dimensional shape and mechanical properties. For instance, ingots that have been melt cast are hot-worked, quenched, cold-worked and then heat-treated at a temperature of 350 – 650°C and aged and precipitation-treated. In addition, solution annealing treatment at 800 – 950°C and water quenching can also be performed during the production processes.

[Effects]

The alloys of the present invention have the above-mentioned composition and in particular, high strength as well as good heat conductivity and electrical conductivity are obtained due to the precipitation and hardening effect that are the result of precipitation of Cr₃Si and Cr₅Si₂ compounds. The stoichiometric ratio of Si when the Cr content is X% is X/5.6 and therefore, it is possible to increase the heat conductivity and the electrical conductivity with the amount of Si in the form of a solid solution kept to a minimum by keeping the Si content in particular to the stoichiometric ratio or lower. In addition to the Cr-Si compound, the Cr precipitates to improve the strength as well as the heat conductivity and the electrical conductivity. Coarse precipitation does not have a strengthening effect and impairs workability and homogeneity. However, a finely dispersed precipitation product is obtained because there is precipitation of the above-mentioned two [elements]. The Cr content is 0.1 – 5%, preferably 1 – 4%. The Si content is 0.02 – 1.0%, preferably 0.1 – 0.8%. Sufficient strength will not be

obtained if either of these are below the lower limit, while workability will be diminished if the upper limits are exceeded.

In addition, there is a total of 0.01 – 3 wt% of any one or two or more of the following within the range of 0.01 – 0.15 wt% P, 0.01 – 0.15 wt% As, 0.01 – 0.15 wt% Sb, 0.05 – 1 wt% Ni, 0.05 – 1 wt% Co, 0.01 – 0.5 wt% Zr, 0.01 – 0.5 wt% Mg, 0.01 – 1 wt% Fe, 0.05 – 3 wt% Zn, 0.05 – 3 wt% Sn, 0.05 – 1 wt% Al, 0.05 – 1 wt% Be, 0.01 – 1 wt% Mn, 0.01 – 1 wt% Ta, 0.01 – 1 wt% Nb, 0.01 – 0.5 wt% Te, 0.01 – 1 wt% Ag, 0.01 – 1 wt% misch metal, and 0.01 – 1 wt% Ti (hereafter these are abbreviated as Y, etc.) because all of these improve strength. Of these Y, etc., P not only further acts as a deoxidant, but also forms a compound with Cr that precipitates to form a precipitation product with high dispersibility. If the Cr precipitates alone, orientation in the worked direction will occur during working, resulting in linear deformation. Therefore, isotropic homogeneity and plating performance of the material will decrease. However, the addition of P prevents this from happening. In addition to further acting as antioxidants, Mn, Sb, Zn, etc., prevent deterioration over time in soldered-joint strength. In particular, Mn prevents oxidation and improves scale adhesion. Zr, Mg, Be, Ta and Nb further provide supplementary precipitation to make fine crystal particles and improve heat resistance and bendability. As with Zn, Mg and Be in particular prevent oxidation and improve scale adhesion. Al, Ni, Co, Fe, Ti, etc., further act as supplementary strengthening components, and the MM and As further act to make the crystals fine. Te and Ag further improve heat resistance. Sn further reduces heat conductivity and electrical conductivity as a

solid solution component, but enhances dispersibility of the precipitation product and has the strengthening effect of a solid solution to improve mechanical properties such as strength and elongation, etc. When strength is particularly important, for instance, when it must be on the level of 60 – 70 kg/mm² or higher, [the Sn] content is 0.75 – 3%. However, if the amounts of these elements added are below the respective lower limit or if the total content is less than 0.01%, the above-mentioned effects will be insufficient, while if each of the elements added exceeds the upper limit, or if the total content exceeds 3%, there will be a marked reduction in heat and electrical conductivity and a reduction in workability.

(Examples)

The alloys shown in Table 1 were combined and melted and cast into molds to obtain ingots that were 25 mm thick, 110 mm wide, and 300 mm long. The surfaces were ground. [The ingot] was then heated and hot drawn at approximately 700°C to a thickness of 5 mm. After water cooling, it was rinsed with acid and cold drawn to a thickness of 0.81 mm. Then it was heat-treated for 4 hours at 350°C and cold-drawn to a thickness of 0.31 mm.

The conductivity, tensile strength, and elongation of the above-mentioned sheet were determined. Moreover, the sheet was bent with a press using a V die at a base angle of 90° and V-type punches with various tip radii (R) and checked for cracking at the bend using a stereoscope. Bending was both in the drawing direction and perpendicular to the drawing direction. The ratio of sheet thickness (t) and tip radius (R) (R/t) was found. Moreover, in order to study solderability, eutectic soldering of a copper lead wire to a part with a width of 5 mm was

performed and [the sample] was aged for 500 hours at 150°C. Then pulling tests were performed. Moreover, in order to investigate adhesion of scales, [samples] were treated for various times over a hot plate at 250 – 400°C and tape peeling tests were conducted. The minimum oxidation thickness at which scales peeled off on the adhesive tape was found. Furthermore, the thickness of the oxide film was determined by the cathode reduction method. In order to study plating performance, a thickness of 0.1 μ was dissolved from the surface using H_2SO_4 - H_2O_2 and then the surface was neutralized with KCN solution and plated to a thickness of 3 μ with Ag. This was heated for 5 minutes over a hot plate that had been heated to 475°C and microscopically checked for blisters. Stress corrosion cracking was studied by keeping a sample in 30 vol% nitric acid salt for 300 hours while applying a weight of 30 kg/mm² and comparing cracking times. These results are shown in Table 2 in comparison to C194 (Cu-2.4% Fe-0.12% Zn-0.03P alloy), MF202 (Cu-2.1% Sn-0.22% Ni-0.08% P alloy), C510 (Cu-5.2% Sn-0.15% alloy and Cu-3.5% Ni-0.61% Si-0.03P alloy), which are conventional lead frame materials.

With the exception of Comparative Alloy No. 26, the O_2 content was 0.001 – 0.0025%.

Table 1.

Alloy	No.	Composition (%)			
		Cr	Si	Other	Cu
Alloy of the present invention	1	3.6	0.16	P 0.05	Remainder
"	2	1.5	0.18	Sn 0.08	"
"	3	0.8	0.1	Sn 2.4 P 0.03	"
"	4	3.6	0.51	Sn 1.5 Mn 0.03	"
"	5	0.25	0.06	Co 0.09 P 0.03	"
"	6	3.6	0.57	Zr 0.09	"
"	7	3.3	0.49	Mg 0.12	"
"	8	1.1	0.15	Be 0.08 Co 0.05	"
"	9	0.4	0.08	Al 0.8 Sb 0.03	"
"	10	0.8	0.15	Fe 0.25 P 0.08	"
"	11	4.4	0.81	Zn 0.6 Mn 0.05	"
"	12	3.6	0.5	Ni 0.15 P 0.05	"
"	13	3.5	0.44	As 0.05 Mn 0.05	"
"	14	3.7	0.78	P 0.03 Zn 1.1	"
"	15	2.5	0.41	Sn 0.6	"
"	16	2.6	0.44	Nb 0.10	"
"	17	2.7	0.41	Ta 0.20	"
"	18	3.3	0.58	Ti 0.1 Ni 0.5	"
"	19	3.5	0.45	Ag 0.3	"
"	20	3.1	0.39	Te 0.1 Mn 0.05	"
"	21	2.6	0.38	Mn 0.15	"
"	22	3.6	0.50	--	"
"	23	3.6	0.01	P 0.05	"
"	24	3.6	1.2	P 0.05	"
"	25	3.5	0.55	Sn 4.5	"
"	26	3.3	0.44	Sn 1.5 O2 0.07	"
"	27	3.6	0.48	Sn 0.03	"
"	28	4.5	0.81	Zn 0.03 MM 0.00	"
"	29	3.5	0.50	Ni 0.03	"
"	30	3.6	0.55	Ni 1.8	"

Table 2.

Alloy	No.	Conduct- ivity (% IACS)	Tensile strength (kg/mm ²)	Elongation (%)	R/t		Solderability (kg/mm ²)	Plating blister	Scale peelability (A)	Stress corrosion cracking (h)
					Drawing direction	Perpendicular direction				
Alloys of the present invention	1	57	61	4.5	1.0	0.8	0.8	No	1200	7300
"	2	62	54	5.6	0.8	0.4	"	"	"	"
"	3	31	60	8.9	0.4	0.4	"	"	800	"
"	4	42	67	5.1	0.8	0.4	0.9	"	950	"
"	5	58	49	7.7	0.6	0.4	0.8	"	1400	"
"	6	58	63	4.9	0.8	0.6	0.7	"	1200	"
"	7	57	64	5.7	0.8	0.6	0.8	"	"	"
"	8	50	59	6.2	0.6	0.6	0.6	"	1100	"
"	9	40	52	7.7	0.6	0.4	0.7	"	1000	"
"	10	53	55	4.9	0.8	0.6	0.6	"	"	"
"	11	46	63	5.1	1.2	0.8	0.7	"	1200	"
"	12	58	62	7.0	1.2	0.8	0.6	"	1000	"
"	13	56	63	5.3	1.0	0.8	0.7	"	1200	"
"	14	39	64	6.0	0.8	0.6	0.5	"	1300	"
"	15	46	58	7.1	0.8	0.4	0.8	"	900	"
"	16	58	59	6.5	0.8	0.6	0.8	"	1300	"
"	17	59	60	5.9	0.8	0.4	0.8	"	1200	"
"	18	55	61	6.1	0.8	0.6	0.7	"	"	"
"	19	60	60	6.9	0.8	0.4	0.9	"	1300	"
"	20	59	58	5.5	1.0	0.8	0.9	"	1000	"
"	21	58	60	5.9	1.0	0.8	0.7	"	"	"

Comparative alloys	22	54	57	5.5	1.6	0.8	0.4	"	1100	"
"	23	73	54	6.0	3.5	0.8	0.5	Yes	1100	"
"	24	23	58	7.1	0.6	0.4	0.2	No	800	"
"	25	12	67	8.1	0.4	0.2	0.6	No	300	85
"	26	46	63	4.9	1.8	1.0	0.8	Yes	800	7300
"	27	51	52	4.2	1.6	0.8	0.7	No	1200	"
"	28	48	62	5.5	1.2	0.8	0.3	No	1100	7300
"	29	57	58	5.9	2.0	1.2	0.8	"	1300	"
"	30	29	61	4.4	1.6	1.2	0.4	"	1100	"
C194	31	64	49	4.4	2.0	1.2	0.5	Yes	1100	"
MF202	32	29	56	6.9	0.4	0.2	0.8	No	800	65
C510	33	15	63	7.7	0.4	0.2	0.3	"	150	250
CuNiSi	34	45	61	4.8	0.8	0.6	0.2	"	650	7300

As is clear from Table 1 and Table 2, satisfactory results are seen in terms of all properties of Alloy Nos. 1 through 21 of the present invention and this is clear when they are compared with Comparative Alloy Nos. 30 – 33. That is, with the exception of Nos. 11 and 14, the alloys of the present invention are structures with excess Cr and therefore, they all show satisfactory properties. Although the conductivity of Alloy Nos. 3 and 4 of the present invention with a particularly high Sn content is low, strength and workability are excellent. Although the conductivity of Alloy Nos. 11 and 14 of the present invention with excess Si is low, the other properties are excellent.

In contrast to this, it is concluded that one or more of the properties of each of Comparative Alloy Nos. 22 – 30 where the composition is outside the range of the alloys of the present invention is inferior. That is, Comparative Alloy No. 22 that does not contain Y, etc., Comparative Alloy No. 23 with a small Si content, Comparative Alloy No. 26 with a high O₂ content, Comparative Alloy No. 27 with a low Sn content, Comparative Alloy No. 29 with a low Ni content, and Comparative Alloy No. 30 with a high Ni content have both poor workability or anisotropy, Comparative Alloy No. 24 with a high Si content and Comparative Alloy No. 25 with a high Sn content both have poor conductivity, and Comparative Alloy No. 28, which does contain Zn and Mn, but in small amounts, has inferior solderability.

[Results of the Invention]

Thus, by means of the present invention, marked results are obtained in that strength as well as heat conductivity and electrical conductivity are all improved, which has proven difficult in the past, and the many properties of workability, solderability, plating performance, etc., that are indispensable for electronic and electrical equipment components in which copper alloys are widely used are improved to the extent that they are suitable for use in semiconductor lead frames, lead wires, various terminals, connectors, conductive springs, etc.

[The Amendment has been incorporated on the first page of the translation.—

Trans. note.]

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⑤発明の名称 導電性高力銅合金

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明 細 書

記載の導電性高力銅合金。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は電子機器の導体、リード、導電性ばね、端子等に用いられる導電性高力銅合金に関し、特に小型高密度化された半導体リードフレームに適した銅合金を提供するものである。

(従来の技術)

電子機器、例えば半導体のリード、各種機器部品の端子、コネクタ、スイッチ等の導電性ばねには銅合金が広く利用され、特にリン青銅は50~65kg/mm²の強度と優れた加工性を有するところから広く普及している。しかしながらこの合金は導電率が10~20%と低いため、導電性(伝熱性)を必要とする部材には用いられず特に小型化、高集積化された半導体用途には使用できない。このためCu-Fe系、Cu-Zr系、Cu-Ni-Si系等の合金が一部で利用されている。

(発明が解決しようとする問題点)

1. 発明の名称

導電性高力銅合金

2. 特許請求の範囲

(1) Cr 0.1~5wt%とSi 0.02~1.0wt%を含み、更にP 0.01~0.15wt%、As 0.01~0.15wt%、Sb 0.01~0.15wt%、Ni 0.05~1wt%、Co 0.05~1wt%、Zr 0.01~0.5wt%、Mg 0.01~0.5wt%、Fe 0.01~1wt%、Zn 0.05~3wt%、Sn 0.05~3wt%、Al 0.05~1wt%、Be 0.05~0.3wt%、Mn 0.01~1wt%、Ta 0.01~1wt%、Nb 0.01~1wt%、Te 0.01~0.5wt%、Ag 0.01~1wt%、ミッシュメタル0.01~1wt%、Ti 0.01~1wt%の範囲内で何れか1種又は2種以上を合計0.01~3wt%含み、残部Cuからなる導電性高力銅合金。

(2) Si量をCrの化学量論比以下とし、O₂量を0.003wt%以下とする特許請求の範囲第1項

Cu-Fe系合金、例えばC-194(Cu-2.4wt%Fe-0.12wt%Zn-P合金)やC-195(Cu-1.5wt%-0.8wt%Co-0.6wt%Sn-P合金)は導電率50~65%IACS、強度45~55Kg/mm²の特性を示すも、より高強度化すると加工性及び半田付け性を低下する。Cu-Cr系合金は80~90%IACS程度の導電性を示すも、Crの粗大結晶が析出し易く、Crを0.7wt%(以下wt%を%と略記)以上として強度を55Kg/mm²以上にしようとする、加工性や材料の均質性、等方性を阻害する。Cu-Zr系合金は90%IACS以上の導電率を示すも、強度が40Kg/mm²以下と小さい。Cu-Ni-Si系合金はNi₂Siを析出する合金でNiとSiの配合及び製造条件により導電率や半田付け性を低下する。即ち未反応のNi、Siに起因し、不可避免的に半田接合部の強度を経時的に低下し、これがプリント基板などに半田付けする通常の実装形態において致命的な欠陥となる。

計0.01~3%含み、残部Cuからなることを特徴とするものであり、特に上記組織範囲内においてSi量をCrの化学量論以下とし、O₂量を0.003%以下とすることが望ましい。

上記合金は常法により容易に製造され、所望の寸法形状と機械的特性が付与される。例えば溶解鋳造したインゴットを熱間加工した後急冷し、次に冷間加工を施してから350~650℃の温度で熱処理し、続いて時効析出処理する。尚製造工程の途中で800~950℃の溶体化処理、水焼入れを行なうこともできる。

(作用)

本発明合金は上記組成範囲からなり、特にCr₃SiやCr₅Si₂の化合物の析出による析出硬化作用により強度と熱・電気伝導性を高度に発揮せしめたもので、Cr含有量をX%とするときのSiの化学量論量はX/5.6となるので、特にSi含有量を化学量論量以下に抑えることにより、固溶Si量を最小限として熱電気伝導性を高めることができる。更にはCr

これに鑑み強度、伸びなどの機械的特性と熱・電気伝導性に優れ、かつ半田付け性、メッキ性、スケール密着性、応力腐食割れなどの耐食性等が優れた特性を有する合金、例えば高強度の特性が要求される半導体リード材に好適な合金の開発が強く望まれている。

(問題点を解決するための手段)

本発明はこれに鑑み種々検討の結果、小型、高密度化された半導体リードフレームに好適な導電性高力銅合金を開発したもので、Cr 0.1~5%とSi 0.02~1.0%を含み、更にP 0.01~0.15%、As 0.01~0.15%、Sb 0.01~0.15%、Ni 0.05~1%、Co 0.05~1%、Zr 0.01~0.5%、Mg 0.01~0.5%、Fe 0.01~1%、Zn 0.05~3%、Sn 0.05~3%、Al 0.05~1%、Be 0.05~0.3%、Mn 0.01~1%、Ta 0.01~1%、Nb 0.01~1%、Te 0.01~1%、Ag 0.01~1%、ミッシュメタル(以下MMと略記) 0.01~1%、Ti 0.01~1%の範囲内で何れか1種又は2種以上を合

-Si化合物に加えてCrが析出して強化と熱・電気伝導性の向上に働き、粗大析出は強化効果に乏しく、加工性や均質性を阻害するが、上記2種の析出が併存するため微細分散した析出物が容易に得られる。しかしてCr含有量は0.1~5%、特に望ましくは1~4%とし、Si含有量は0.02~1.0%、特に望ましくは0.1~0.8%であり、何れも下限未満では十分な強度が得られず、上限を越えると製造加工性を低下する。

またP 0.01~0.15%、As 0.01~0.15%、Sb 0.01~0.15%、Ni 0.05~1%、Co 0.05~1%、Zr 0.01~0.5%、Mg 0.01~0.5%、Fe 0.01~1%、Zn 0.05~3%、Sn 0.05~3%、Al 0.05~1%、Be 0.05~1%、Mn 0.01~1%、Ta 0.01~1%、Nb 0.01~1%、Te 0.01~0.5%、Ag 0.01~1%、MM 0.01~1%、Ti 0.01~1%(以下これ等をY等と略記)の範囲内で何れか1種又は2種以上の合計含有量を0.01~3%としたのは、これ等は

れも強度を向上するためであり、これ等Y等のうちPは更に脱酸剤として作用するばかりか、Crとの化合物を析出し、分散性の高い析出物を生じ、特にCr単体の析出が製造加工時に加工方向に配向して線状に変形し、材料の等方均質性やメッキ性を低下するも、Pの添加はこれを防止する。Mn、Sb、Zn等は更に脱酸剤として作用すると共に、半田接続強度の経時劣化を防止し、特にMnは酸化抑制及びスケールの密着性を向上する。Zr、Mg、Be、Ta、Nbは更に補助的に析出して結晶粒を微細化すると共に耐熱性及び折り曲げ性を向上し、特にMg、BeはZnと同様に酸化抑制とスケールの密着性を向上する。Al、Ni、Co、Fe、Ti等は更に補助的な強化成分として作用し、MM、Asは更に結晶の微細化として働き、Te、Agは更に耐熱性を向上する。Snは更に固溶成分として熱・電気伝導性を低下するも析出物の分散性を高め、固溶強化作用と相まって強度、伸び等の機械的特性を向上し、特に強

度を必要とする場合、例えば60~70kg/mm²級、又はそれ以上の場合には0.75~3%を含有せしめる。しかしてこれ等添加元素はそれぞれに下限未満でも合計含有量が0.01%未満でも上記効果が不十分となり、各添加元素が上限を越えても、合計含有量が3%を越えても熱・電気伝導性及び加工性の低下が著しくなる。

(実施例)

第1表に示す合金を配合溶解し、金型に铸造して厚さ25mm、幅110mm、長さ300mmの铸塊として面削を行なった。これを加熱して約700℃以上で厚さ5mmまで熱間圧延を行なって水冷した後酸洗し、しかる後厚さ0.81mmまで冷間圧延してから350℃で4時間加熱処理し、続いて厚さ0.31mmまで冷間圧延した。

上記板材について導電率、引張強さ及び伸びを測定すると共に、底角90°のV溝ダイと各種先端半径(R)のV型ポンチを用いてプレスにより折り曲げ加工し、該曲げ部の割れを実体検鏡した。曲げは圧延方向及び該方向と直角方向

とし、板厚(t)と先端半径(R)の比(R/t)を求めた。また半田付け性を見るため、幅5mmの部分にリード銅線を共晶半田付けした後、150℃に500時間放置してからプルテストを行なった。またスケールの密着性を調べるため、250~400℃のホットプレート上で種々の時間処理し、テープ剥離試験を行なって粘着テープ上にスケールが剥離する最小酸化厚さを求めた。尚酸化膜の厚さはカソード還元法により測定した。更にメッキ性を調べるためH₂SO₄-H₂O₂液で表面を厚さ0.1μ溶解した後、KCN溶液で中和してから3μの厚さにAgメッキし、これを475℃に加熱したホットプレート上で5分間加熱してからフレクの有無を検鏡した。応力腐食割れは30vol%の硝酸塩中で30kg/mm²の荷重をかけながら300時間保持し、割れ発生の時間を比較した。これ等の結果を従来のリードフレーム材であるC194(Cu-2.4%Fe-0.12%Zn-0.03P合金)、MF202(Cu-2.1%Sn-0.22%Ni-0.08%

P合金)、C510(Cu-5.2%Sn-0.15%合金及びCu-3.5%Ni-0.61%Si-0.03P合金)と比較して第2表に示す。

尚比較合金N0.26を除きO₂含有量は0.001~0.0025%であった。

第 1 表

合金別	No.	組 成 (%)			
		Cr	Si	そ の 他	CU
本発明合金	1	3.5	0.16	P 0.05	残
"	2	1.5	0.18	Sn 0.08	"
"	3	0.8	0.1	Sn 2.4 P 0.03	"
"	4	3.6	0.51	Sn 1.5 Mn 0.03	"
"	5	0.25	0.06	Co 0.09 P 0.03	"
"	6	3.6	0.57	Zr 0.09	"
"	7	3.3	0.49	Mg 0.12	"
"	8	1.1	0.15	Be 0.08 Co 0.05	"
"	9	0.4	0.08	Al 0.8 Sb 0.03	"
"	10	0.8	0.15	Fe 0.25 P 0.08	"
"	11	4.4	0.81	Zn 0.6 Mn 0.05	"
"	12	3.6	0.5	Ni 0.15 P 0.05	"
"	13	3.5	0.44	As 0.05 Mn 0.05	"
"	14	3.7	0.78	P 0.03 Zn 1.1	"
"	15	2.5	0.41	Sn 0.6	"
"	16	2.6	0.44	Nb 0.10	"
"	17	2.7	0.41	Ta 0.20	"
"	18	3.3	0.58	Ti 0.1 Ni 0.5	"
"	19	3.5	0.45	Ag 0.3	"
"	20	3.1	0.39	Te 0.1 Mn 0.05	"
"	21	2.6	0.38	Mn 0.15	"

第 1 表 (2)

合金別	No.	組 成 (%)			
		Cr	Si	そ の 他	CU
比較合金	22	3.6	0.50	—	残
"	23	3.6	0.01	P 0.05	"
"	24	3.6	1.2	P 0.05	"
"	25	3.5	0.55	Sn 4.5	"
"	26	3.3	0.44	Sn 1.5 O ₂ 0.07	"
"	27	3.6	0.48	Sn 0.03	"
"	28	4.5	0.81	Zn 0.03 MM 0.00	"
"	29	3.5	0.50	Ni 0.03	"
"	30	3.6	0.55	Ni 1.8	"

第 2 表

合金別	No.	導 電 率 (% IACS)	引 張 強 さ (kg/mm ²)	伸 び (%)	R/t		半田付け性 (kg/mm ²)	メッキ フクレ	スケール剥離性 (Å)	応力腐食割れ (hr)
					圧延方向	直角方向				
本発明合金	1	57	61	4.5	1.0	0.8	0.8	なし	1200	7300
"	2	62	54	5.6	0.8	0.4	"	"	"	"
"	3	31	60	8.9	0.4	0.4	"	"	800	"
"	4	42	67	5.1	0.8	0.4	0.9	"	950	"
"	5	58	49	7.7	0.6	0.4	0.8	"	1400	"
"	6	58	63	4.9	0.8	0.6	0.7	"	1200	"
"	7	57	64	5.7	0.8	0.6	0.8	"	"	"
"	8	59	59	6.2	0.6	0.6	0.6	"	1100	"
"	9	40	52	7.7	0.6	0.4	0.7	"	1000	"
"	10	53	55	4.9	0.8	0.6	0.6	"	"	"
"	11	46	63	5.1	1.2	0.8	0.7	"	1200	"
"	12	58	62	7.0	1.2	0.8	0.6	"	1000	"
"	13	56	63	5.3	1.0	0.8	0.7	"	1200	"
"	14	39	64	6.0	0.8	0.6	0.5	"	1300	"
"	15	46	58	7.1	0.8	0.4	0.8	"	900	"
"	16	58	59	6.5	0.8	0.6	0.8	"	1300	"
"	17	59	60	5.9	0.8	0.4	0.8	"	1200	"
"	18	55	61	6.1	0.8	0.6	0.7	"	"	"
"	19	60	60	6.9	0.8	0.4	0.9	"	1300	"
"	20	59	58	5.5	1.0	0.8	0.9	"	1000	"
"	21	58	60	5.9	1.0	0.8	0.7	"	"	"
比較合金	22	54	57	5.5	1.6	0.8	0.4	"	1100	"
"	23	73	54	6.0	3.5	0.8	0.5	あり	1100	"
"	24	23	58	7.1	0.6	0.4	0.2	なし	800	"
"	25	12	67	8.1	0.4	0.2	0.6	"	300	85
"	26	46	63	4.9	1.8	1.0	0.8	あり	800	7300
"	27	51	52	4.2	1.6	0.8	0.7	なし	1200	"

第 2 表 (2)

合 金 別	No.	導 電 率 (% IACS)	引 張 強 さ (Kg/mm ²)	伸 び (%)	R / t		半田付け性 (Kg/mm ²)	メッキ フクレ	スケール剥離性 (△)	応力腐食割れ (hr)
					圧延方向	直角方向				
比 較 合 金	28	48	62	5.5	1.2	0.8	0.3	な し	1100	7300
"	29	57	58	5.9	2.0	1.2	0.8	"	1300	"
"	30	29	61	4.4	1.6	1.2	0.4	"	1100	"
C194	31	64	49	4.4	2.0	1.2	0.5	あ り	1100	"
MF202	32	29	56	6.9	0.4	0.2	0.6	な し	800	65
C510	33	15	63	7.7	0.4	0.2	0.3	"	150	250
CuNiSi	34	45	61	4.8	0.8	0.6	0.2	"	650	7300

第1表及び第2表から明らかなように本発明合金No.1~21は何れの特性においても満足する結果を示しており、このことは従来合金No.30~33と比較すれば明らかである。即ち本発明合金はNo.11、14を除きCr過剰組成のもので、何れも満足できる特性を示し、特にSn含有量の多い本発明合金No.3~4では導電率は低いが強度及び加工性が優れており、Si過剰の本発明合金No.11、14も導電率は低いがその他の特性が優れている。

これに対し本発明合金の組成範囲から外れる比較合金No.22~30では特性の何れか一つ以上が劣ることが判る。即ちY等を含まない比較合金No.22、Si含有量の少ない比較合金No.23、O₂含有量の多い比較合金No.26、Sn含有量が少ない比較合金No.27、Ni含有量の少ない比較合金No.29及びNi含有量の多い比較合金No.30は何れも加工性及び等方性が劣り、Si含有量の多い比較合金No.24及びSn含有量の多い比較合金No.25では何れも導電性が劣り、

更にZnとMnを含むもその含有量が少ない比較合金No.28では半田付け性が劣ることが判る。(発明の効果)

このように本発明によれば、従来両立させることが困難な強度と熱電気伝導性を共に向上し、かつ銅合金が広く用いられる電子・電気機器部品として不可欠な加工性、半田付け性、メッキ性等の諸特性を充分満足できるレベルに向上したもので、半導体リードフレーム、リード線、各種端子、コネクタ、導電性ばね等に使用し、顕著な効果を奏するものである。

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第1頁の続き

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